

# **The Microbial Rosetta Stone Database Project**

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**A Division of Isis Pharmaceuticals**

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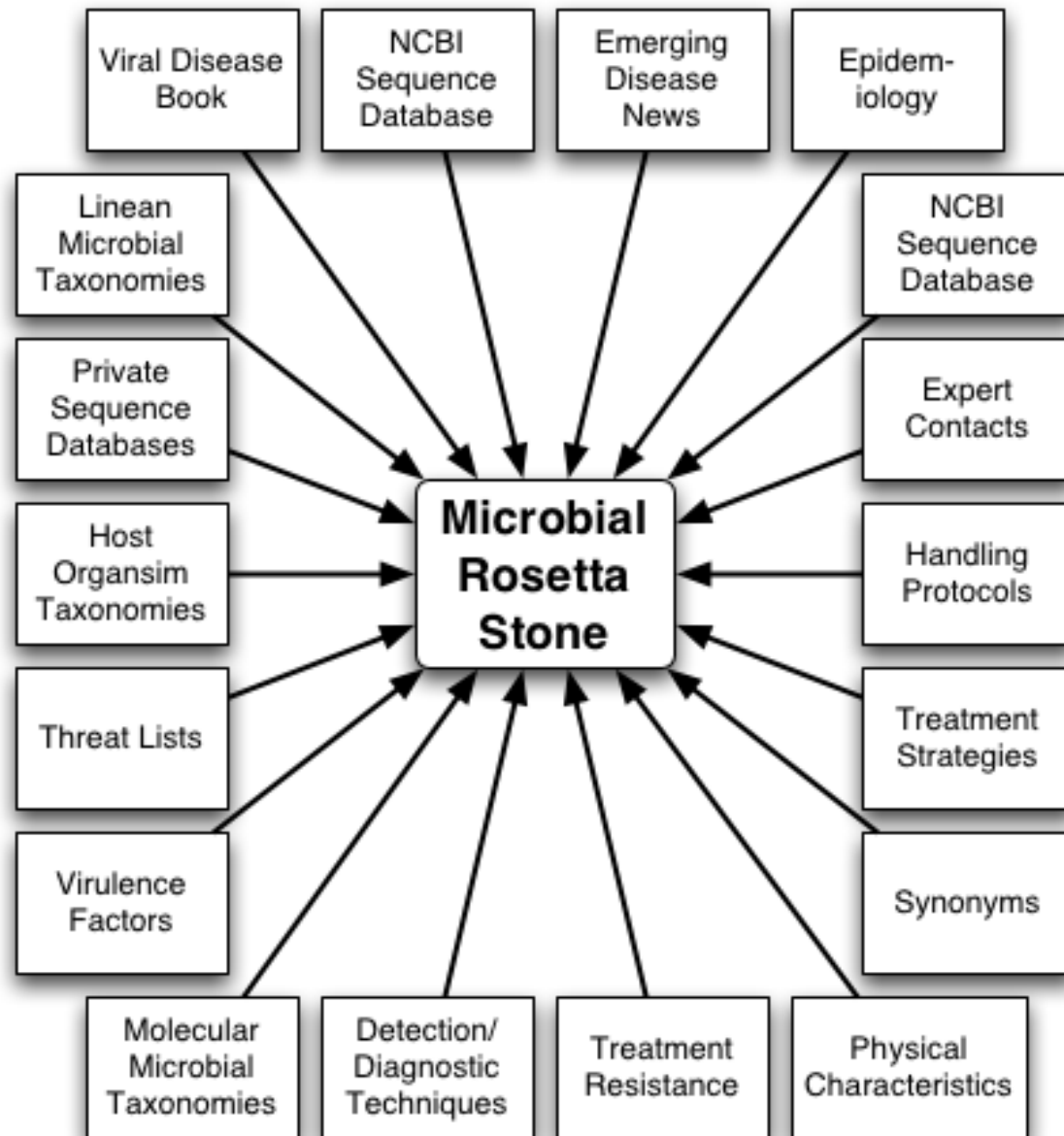
# Needs of law enforcement

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- **MRS project was motivated by the need to map the complete landscape of infectious agents**
  - **Initially funded by DARPA**
- **Additional support from the FBI for “microbial forensics”**
- **Main intent is to help define attribution in case of a bioterror event**
  - **Is the threat credible?**
  - **What is the threat agent?**
  - **Has it been engineered?**
  - **Who has access to it?**

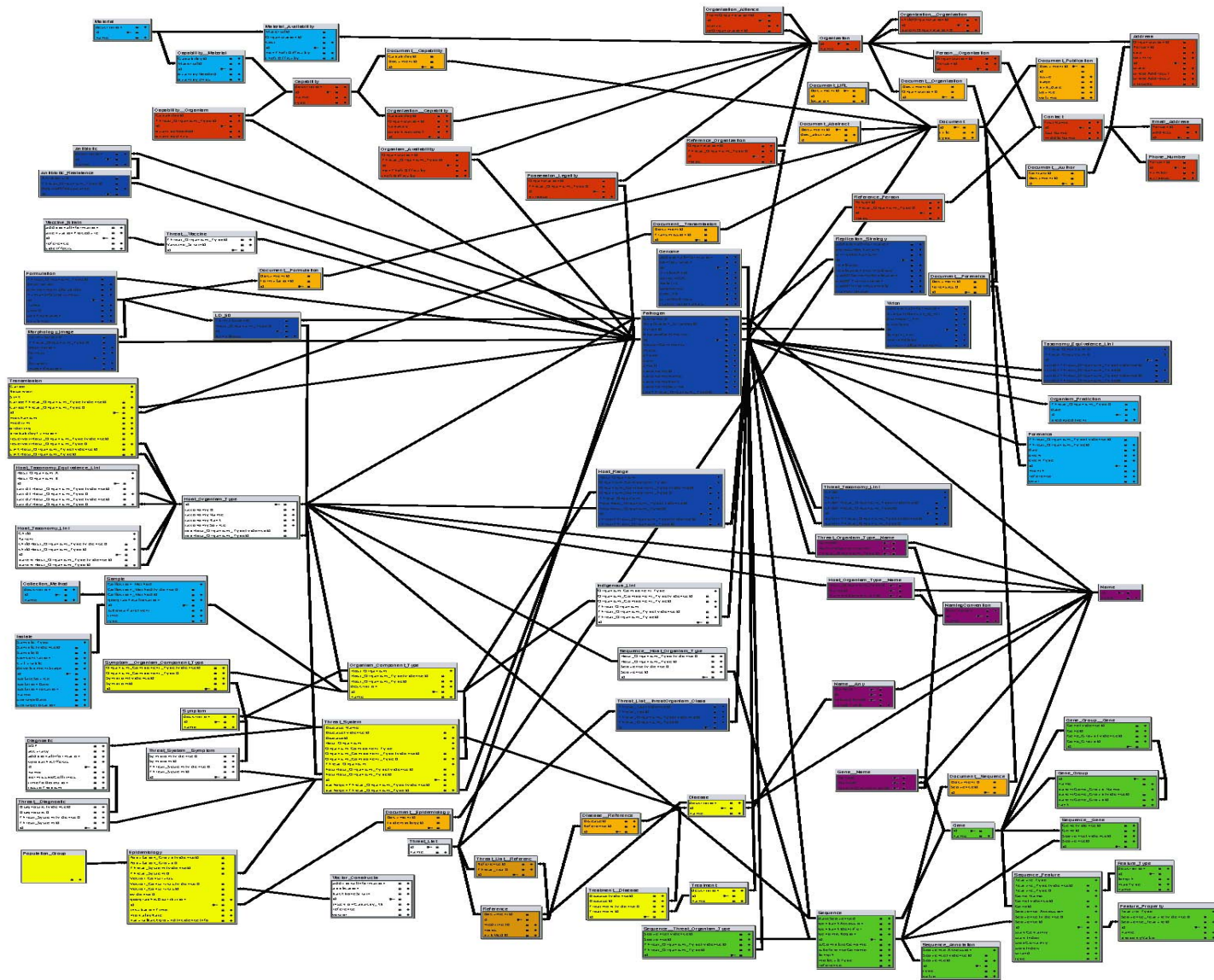


# Pathogen Database Data Sources





# MRS Database Schema



- Pathogen
- Disease
- Sequence
- Labs/  
Protocols
- Forensics
- Documents
- Names/  
synonyms





# MRS web-based UI

FBInterface: QueryAll

Go to this address

Google Apple MRS\_Edit MRS\_Interface

**Federal Bureau of Investigation**  
**www.fbi.gov**





[Home](#) | [Contact](#) | [Disease](#) | [Document](#) | [Forensics](#) | [Sequence](#) | [Pathogen](#) | [Threat List](#) | [Log Out](#)

## Microbial Rosetta Stone

☒ Any ☐ All

### Find

#### Entities

|                |       |                  |    |   |  |   |
|----------------|-------|------------------|----|---|--|---|
| Contact        | where | lastName         | is | = |  |    |
| Disease        | where | name             | is | = |  |    |
| Document       | where | title            | is | = |  |    |
| Forensics      | where | year             | is | = |  |   |
| Pathogen       | where | taxonomyName     | is | = |  |  |
| Sequence       | where | genbankAccession | is | = |  |  |
| Threat List    | where | name             | is | = |  |  |
| Genome         | where | nucleicAcid      | is | = |  |  |
| Characteristic | where | charType         | is | = |  |  |
| Keyword        | where | value            | is | = |  |  |



# Pathogen report

FBInterface: Report Pathogen

Go to this address  Google

Isis web mail Google Apple MRS\_Edit MRS\_Interface

[System Documentation](#)  
[FBI Edit Page](#)  
[BDAP](#)  
[Bioforensics Evidence Network](#)  
[National Bioforensics Information Encyclopedia](#)  
[CBIAC](#)  
[Clinicians' Biodefense Network](#)  
[CDC Public Health Image Library](#)

[Back](#) [Inspect](#)

## Pathogen

|                 |                              |
|-----------------|------------------------------|
| Pathogen Name   | Foot-and-mouth disease virus |
| Taxonomy Rank   | species                      |
| Taxonomy Source | Isis                         |

**Synonym(s):**  
Foot-and-mouth disease virus  
FMDV  
Foot and mouth disease virus  
foot and mouth disease virus FMDV  
foot-and-mouth disease virus FMDV

**Lineage:**  
[Picornaviridae->Aphthovirus](#)

**Equivalent Pathogen(s):**  
[Foot-and-mouth disease virus \(ICTV\)](#)  
[Foot-and-mouth disease virus \(NCBI\)](#)

**Capability Information: 5 found**

|   |  |
|---|--|
| 1 | Name: SNAP hybridization for foot-and-mouth diagnosis<br>Organization(s): <a href="#">Institute for Animal Health</a><br>Document(s): <a href="#">Development of reverse transcription-PCR (oligonucleotide probing) enzyme-linked immunosorbent assays for diagnosis and preliminary typing of foot-and-mouth disease: a new system using simple and aqueous-phase hybridization.</a> |
| 2 | Name: Nucleic Acid Sequence-Based Amplification (NASBA)<br>Organization(s): <a href="#">Hong Kong DNA Chips Ltd</a><br>Document(s): <a href="#">A method to detect major serotypes of foot-and-mouth disease virus</a>   |
| 3 | Name: Restriction Enzyme and Nucleotide Sequence Analysis<br>Organization(s): <a href="#">Indian Veterinary Research Institute</a>   |



# Disease report

FBInterface: Report Disease

Go to this address

Google

Google Apple MRS\_Edit MRS\_Interface

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## Disease

**Name(s): 1 found**

1 Soybean rust

**Description**

Soybean rust is caused by two fungal species, *Phakopsora pachyrhizi*, an aggressive Australasian species and *Phakopsora meibomia*, a weaker new world species. Yield losses from *P. pachyrhizi* have been reported from 10-80%. Environmental conditions impact the severity of the disease. Prolonged leaf wetness combined with temperatures between 59 and 86 degrees F and humidity of 75-80% is required for spore germination and infection.

**Unique Host/Pathogen Correlations: 19 found**

1 [Glycine max](#) / [Phakopsora pachyrhizi](#)

| 1 | Component Type:                         |
|---|---|
|   | <b>Symptom: 8 found</b>                 |
| 1 | chlorosis                               |
| 2 | yield loss                              |
| 3 | chlorosis                               |
| 4 | necrosis                                |
| 5 | chlorosis and necrosis of older leaves  |
| 6 | yellowing of leaves                     |
| 7 | defoliation                             |
| 8 | tan or reddish brown pustules on leaves |

System  
Documentation  
FBI Edit Page  
BDAP  
Bioforensics  
Evidence  
Network  
National  
Bioforensics  
Information  
Encyclopedia  
CBIAC  
Clinicians'  
Biodefense  
Network  
CDC Public  
Health Image  
Library

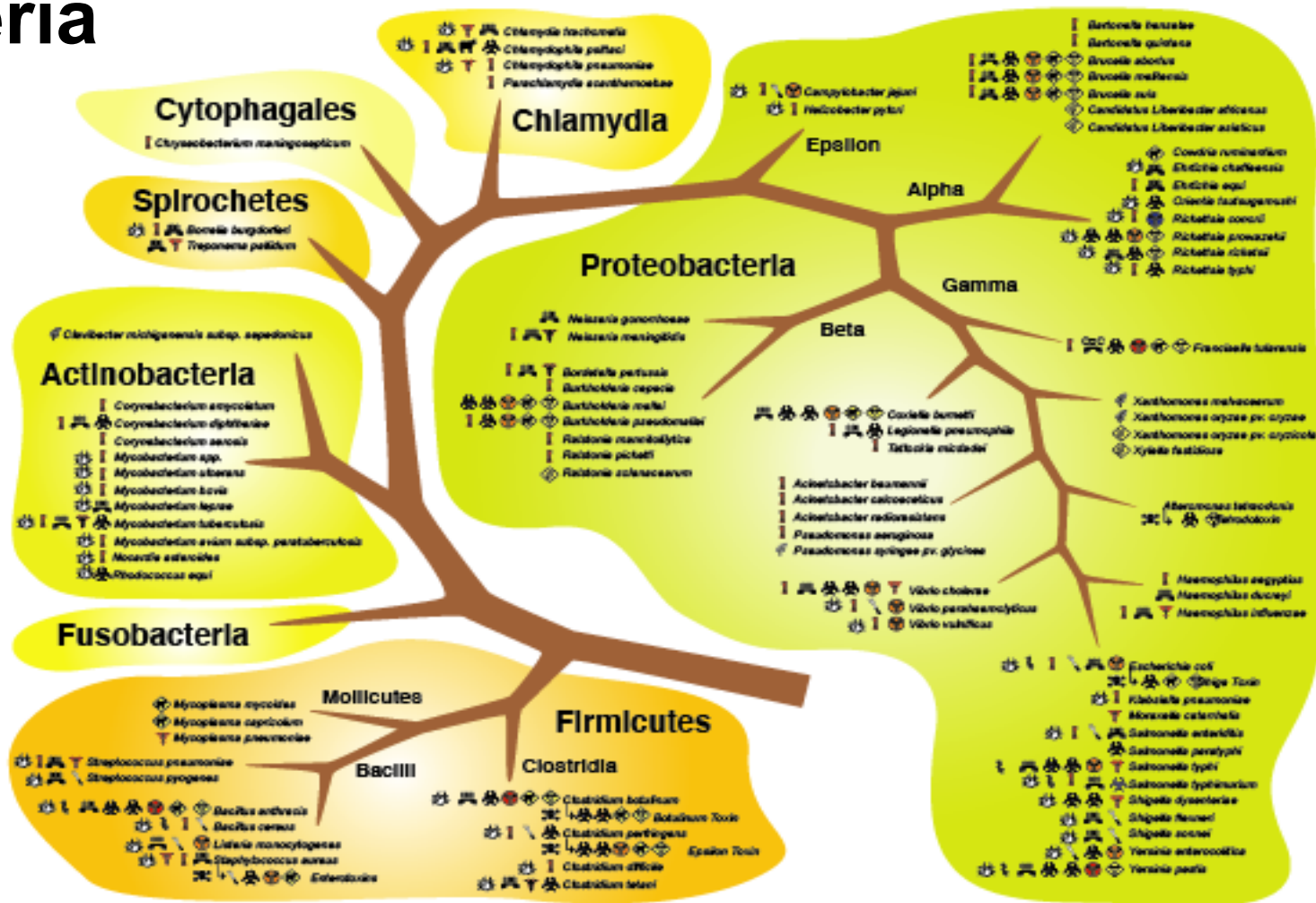


# Data Conflicts Example: Threat Lists

- **Government agencies create threat lists to focus diagnostic or therapeutic efforts**
  - CDC, USDA, NIAID, DoD
- **Lists are also created for specific purposes, for example:**
  - Organisms that infect the human respiratory system, important in the clinic
- **For detection, must link pathogens to potential biomarkers and other characteristics**
  - Lists often use inconsistent naming conventions (e.g., disease names mixed with species names)
  - Breadth and specificity of biomarkers is constantly evolving; need to document links extensively to support their accuracy
- **Database must provide unambiguous, fully linked, threat lists**



# Bacteria



### Key to Icons

- |  |   |
|--|---|
|  NIAID Category A                       |  Globally Important Human Pathogen |
|  NIAID Category B                       |  Important Plant Pathogen          |
|  NIAID Category C                       |  CDC Reportable Agent              |
|  CDC Select Agent                       |  Emerging Infectious Agent         |
|  USDA High Consequence Animal Pathogen  |  Principal Foodborne Pathogen      |
|  USDA High Consequence Plant Pathogen   |  Toxin                             |
|  Validated Bioweapon                    |  Zoonotic                          |
|  Potential Bioweapon                    |  High Potential For Bioengineering |
|  Validated Biocrime and Bioterror Agent |   |



# Data Mining Approach: List Based Query/Drill-Down

Rosetta Stone Database Viewer

File Edit View Query Tools Help

**Query Panel**

- Sequence Feature
- Specific Threat
- Symptom
- Threat List
  - 1 Threat List(s)
    - Threat Organism
      - 37 Threat Organism(s)
        - Antibiotic Resistance
        - Capability
        - Characteristic
        - Organism History
        - Formulation
        - Genome
        - Morphology Image
        - Name
        - Organism Component Type
        - Threat Organism
        - Reference Organization
        - Reference Person
        - Virus Replication
        - Sequence
        - Threat List
        - Specific Threat
          - 92 Specific Threat(s)
            - Diagnostic
            - Disease
            - Epidemiology
            - Evidence
            - Host Organism
            - Organism Component Type
            - Threat Organism
            - Symptom
          - Trace
          - threat has vaccine link
          - Vaccine Strain
          - Virus

**Result Panel**

| Name                 | Host Organism          | Threat Organism                    | Disease Name                      |
|----------------------|------------------------|------------------------------------|-----------------------------------|
| DHS Agricultural ... | Phacochoerus afric...  | African swine fever virus          | African swine fever               |
| DHS Agricultural ... | Suidae                 | African swine fever virus          | African swine fever               |
| DHS Agricultural ... | Sus scrofa             | African swine fever virus          | African swine fever               |
| DHS Agricultural ... | Malus x domestica      | Candidatus Phytoplasma mali        | Apple proliferation               |
| DHS Agricultural ... | Cucumis sativus        | Ralstonia solanacearum             | Bacterial wilt                    |
| DHS Agricultural ... | Cucumis sativus        | Erwinia tracheiphila               | Bacterial wilt                    |
| DHS Agricultural ... | Cucumis sativus        | Pantoea stewartii subsp. stewartii | Bacterial wilt                    |
| DHS Agricultural ... | Cucurbita pepo         | Ralstonia solanacearum             | Bacterial wilt                    |
| DHS Agricultural ... | Cucurbita pepo         | Erwinia tracheiphila               | Bacterial wilt                    |
| DHS Agricultural ... | Cucurbita pepo         | Pantoea stewartii subsp. stewartii | Bacterial wilt                    |
| DHS Agricultural ... | Zea mays               | Sclerophthora rayssiae var. zeae   | Brown stripe downy mildew         |
| DHS Agricultural ... | Citrus aurantiifolia   | Xanthomonas axonopodis pv. Citri   | Citrus canker                     |
| DHS Agricultural ... | Citrus hybrid cultivar | Candidatus Liberibacter africanus  | Citrus greening                   |
| DHS Agricultural ... | Citrus hybrid cultivar | Candidatus Liberibacter asiaticus  | Citrus greening                   |
| DHS Agricultural ... | Citrus limon           | Candidatus Liberibacter africanus  | Citrus greening                   |
| DHS Agricultural ... | Citrus limon           | Candidatus Liberibacter asiaticus  | Citrus greening                   |
| DHS Agricultural ... | Citrus reticulata      | Candidatus Liberibacter africanus  | Citrus greening                   |
| DHS Agricultural ... | Citrus reticulata      | Candidatus Liberibacter asiaticus  | Citrus greening                   |
| DHS Agricultural ... | Citrus x paradisi      | Candidatus Liberibacter africanus  | Citrus greening                   |
| DHS Agricultural ... | Citrus x paradisi      | Candidatus Liberibacter asiaticus  | Citrus greening                   |
| DHS Agricultural ... | Suidae                 | Classical swine fever virus        | classical swine fever (CSF)       |
| DHS Agricultural ... | Sus scrofa             | Classical swine fever virus        | classical swine fever (CSF)       |
| DHS Agricultural ... | Bos taurus             | Mycoplasma mycoides                | Contagious Bovine Pleuropneumonia |
| DHS Agricultural ... | Prunus armeniaca       | Monilinia fructicola               | European brown rot                |
| DHS Agricultural ... | Prunus armeniaca       | Monilinia fructigena               | European brown rot                |
| DHS Agricultural ... | Prunus armeniaca       | Monilinia laxa                     | European brown rot                |
| DHS Agricultural ... | Prunus domestica       | Monilinia fructicola               | European brown rot                |
| DHS Agricultural ... | Prunus domestica       | Monilinia fructigena               | European brown rot                |
| DHS Agricultural ... | Prunus domestica       | Monilinia laxa                     | European brown rot                |
| DHS Agricultural ... | Bos taurus             | Foot-and-mouth disease virus       | Foot-and-mouth disease            |
| DHS Agricultural ... | Capra hircus           | Foot-and-mouth disease virus       | Foot-and-mouth disease            |
| DHS Agricultural ... | Ovis aries             | Foot-and-mouth disease virus       | Foot-and-mouth disease            |
| DHS Agricultural ... | Suidae                 | Foot-and-mouth disease virus       | Foot-and-mouth disease            |
| DHS Agricultural ... | Embryophyta            | Plum pox virus                     | generic diseases                  |

Inspector Panel

Idle.

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# Defining Bacterial wilt

| Threat list          | Host organism   | Threat organism                    | Disease        |
|----------------------|-----------------|------------------------------------|----------------|
| DHS Agricultural ... | Cucumis sativus | Ralstonia solanacearum             | Bacterial wilt |
| DHS Agricultural ... | Cucumis sativus | Erwinia tracheiphila               | Bacterial wilt |
| DHS Agricultural ... | Cucumis sativus | Pantoea stewartii subsp. stewartii | Bacterial wilt |
| DHS Agricultural ... | Cucurbita pepo  | Ralstonia solanacearum             | Bacterial wilt |
| DHS Agricultural ... | Cucurbita pepo  | Erwinia tracheiphila               | Bacterial wilt |
| DHS Agricultural ... | Cucurbita pepo  | Pantoea stewartii subsp. stewartii | Bacterial wilt |



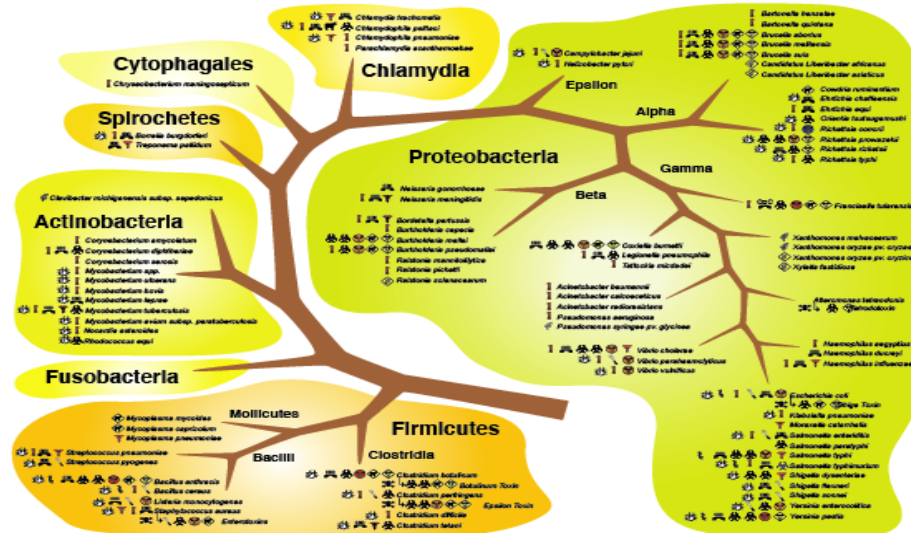
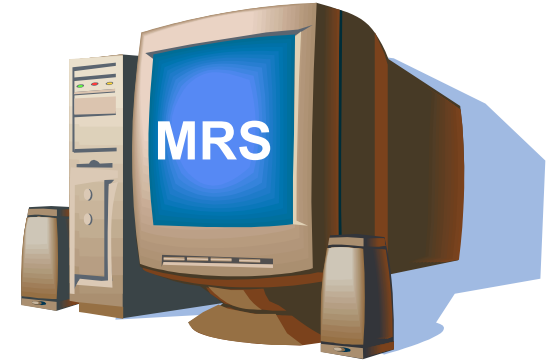
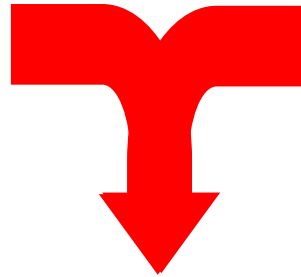
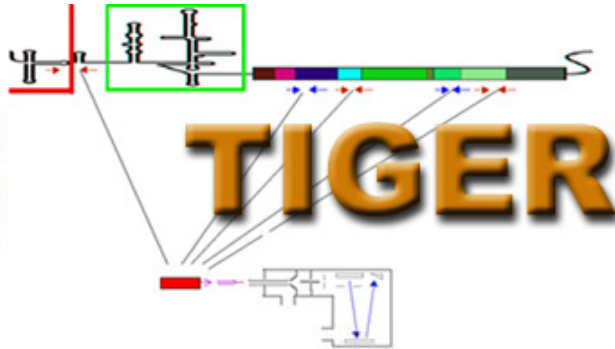
# MRS System Attributes

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- **Standard relational database (MySQL)**
- **Automated data loading scripts for GenBank and taxonomy data from NCBI**
- **Automated data curation scripts for connecting different taxonomies for pathogens**
- **Automated keyword indexing for documents (publications, protocols, etc.)**
- **Multiple interfaces for data import and editing**



# Synergy with detection systems



## Key to Icons

- NIAID Category A
- NIAID Category B
- NIAID Category C
- CDC Select Agent
- USDA High Consequence Animal Pathogen
- USDA High Consequence Plant Pathogen
- Validated Bioweapon
- Potential Bioweapon
- Validated Biothreat and Bioterror Agent

- † Globally Important Human Pathogen
- † Important Plant Pathogen
- † CDC Reportable Agent
- † Emerging Infectious Agent
- † Principal Foodborne Pathogen
- † Toxin
- † Zoonotic
- † High Potential For Bioengineering



# Uses of MRS

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- **Interface with and development of other detection platforms**
- **Informatics tool for first responders and field agents**
- **Microbial forensics and strain tracking tool**
- **Educational reference for DHS and health care managers**
- **Other?**



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